

## KNEE-DISARTICULATION AMPUTATION <sup>a</sup>

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Amputations below-thigh level and proximal to knee-disarticulation level include all the transcondylar procedures such as the Gritti Stokes (1,2) and Callender (3,4) procedures and are not considered in this contribution. In my view they are largely undesirable because they provide little end bearing, may not leave sufficient space for the inclusion of assistive devices in the prosthetic knee, and are perhaps better replaced by a long myoplasty amputation. The Gritti Stokes procedure in particular often gives rise to a number of complications most of these being due to the retention of the patella. Recent contributions suggest this operation is excellent at least in terms of wound healing. Unfortunately, it has persuaded a number of surgeons to employ the procedure for this reason alone.

We are concerned in this contribution with the through-knee amputation or knee disarticulation. At the outset I should say that there seems to me very little validity in an argument about the relative merits of operative procedures at different levels of limb ablation except in the individual case. On this basis it will be assumed that an amputation can properly be done below-thigh level but for one reason or another cannot be done at below-knee level.

The knee-disarticulation operation has a long history of use extending back to the sixteenth century if not before (5,6,7,8). Like many surgical procedures its popularity has waxed and waned with changing surgical fashion and in this particular case with the prosthetic practice of the day.

I believe the procedure has a stated place in our surgical armamentarium.

In the first place it has a particular application during the growth period as it preserves the distal femoral epiphysis and thus the capacity for 80-90 percent of femoral growth. In this way we obtain a stump of maximum length when skeletal maturity is reached yet somewhat shorter than the

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femur on the other leg thus allowing the inclusion of assistive devices in the prosthesis. The stump will demonstrate its other advantages; viz:

1. A large end-bearing surface covered with tissues adapted to this situation as in kneeling: in the adult the area is between 14 and 20 sq. in.
2. It provides a long strong lever where most of the muscles have a satisfactory status in physiological terms.
3. A bulbous end insuring rotational stability and good suspension.
4. Because of the factors mentioned, proprioception is excellent.

All these listed advantages immediately suggest the knee-disarticulation stump as of particular value to the elderly and this, I believe, is so. Once certain principles are accepted the operation is particularly suitable for the elderly atherosclerotic as the procedure is relatively bloodless with minimum division of soft tissue and can be performed comfortably in 30 minutes. In all cases of atherosclerosis requiring amputation and where this is not deemed advisable at below-knee level, the disarticulation should be given serious consideration before a thigh amputation is performed. In the circumstances found in these cases I cannot find justification for modifications such as excision of the patella or trimming of the femoral condyles, as they lengthen operative time, increase the chance of bleeding, and may prejudice the blood supply to the flap. It is fair to mention the fact that the patient with two knee disarticulations will fare better than the double above-knee amputee, with or without prostheses. This, however, is a complicated situation and other factors will influence decision in these cases.

In the young male adult the operation has much to commend it and especially in those who are particularly active, perform heavy work, or live under rough conditions.

I do not believe that it is a good amputation to perform on a young woman because cosmetically the prosthesis is not satisfactory. In these circumstances even if the pathology and other relevant factors allow a disarticulation, I would undertake a low myoplasty of the thigh.

It is a procedure which should not be done where there is a fixed permanent flexion deformity of the hip or where a below-knee amputation is feasible.

The operation is best done with the patient lying prone and the affected knee flexed. This has the additional advantage of reminding the surgeon of the importance of any existing hip flexion deformity and it also permits surgical approach to both back and front of the joint. The classical procedure requires that the anterior flap should be twice as long as the posterior flap and that the anterior flap at its lowest point will be 1 in. distal to the insertion of the patellar tendon or expressed in other terms, it is a full hands-breadth below the patella. With the knee flexed the anterior dissection continues to joint level. The philosophy of the surgery is to keep the knife close

to bone and dissect up the anterior flap as one completely undisturbed hood of tissue. Where applicable the knife will dissect the tissues from the bone and in this way the front flap will contain, from the surface inward, skin, subcutaneous tissue, bursae, deep fascia, patellar tendon and patella, capsule and the muscular expansions of the front of the knee and the retropatellar fat pad. In this way the pes anserinus is elevated along with the hood of tissue insuring attachment for the sartorius, gracilis and semitendinosus, and of course the quadriceps extensor itself. Once the anterior flap has been elevated in this way and the joint exposed, the cruciate ligaments may be divided. Attention is then directed toward the posterior aspect of the extended joint, and after delineating the posterior flap which is rather short and rectangular in shape the deep fascia is divided in line with it. The heads of the gastrocnemius are isolated and divided along with the plantaris muscle. The popliteal artery and vein are easily isolated, ligated, and divided at a low level in order to preserve any useful branches. The lateral and medial popliteal nerves are pulled down gently and divided by a clean cut with the usual proviso regarding any abnormally large vessels. The biceps tendon is divided and the posterior capsule then alone remains for division. It will be recalled that the tendon of semimembranosus is inserted into the posterior aspect of the head of the tibia, the fascia overlying the popliteus, and the capsule itself, and if the capsule is divided as low as possible, then we retain the insertion of this muscle. The patellar tendon is then sutured firmly to the stump of the cruciate ligaments and the anterior muscle expansions and capsule are sutured to the posterior capsule of the joint thus insuring fixation of the quadriceps in front and the hamstring muscles behind with the exception of the round tendon of the biceps. This too should be sutured separately at rest length or slightly shorter.

In this way the joint is in effect reconstituted. Dr. Vitali (9) at Roehampton says that this is a bad practice as they have several times seen effusions in the reconstituted knee joint. I have not seen this complication but accept it as a theoretical possibility. Even so the procedure I have described is attractive from a physiological point of view as it retains the same tissue arrangement as in the kneeling normal limb thus permitting maximum end loads. Furthermore, with the practice of elevating the anterior flap and the posterior capsule in the way described, we have restored a near physiological situation for the muscles remaining in the stump.

It will then be found that suture of the skin leaves a very loose suture line. Surgeons unpracticed in this operation are advised to avoid trimming the anterior flap as once the wound has healed the looseness of the skin is not apparent; whereas, if any tension is employed at this level of operation a broad adherent scar will result. If suture of the incision requires considerable tension then inevitably high load areas will appear over the posterior aspects of the femoral condyles and skin necrosis is inevitable. There

seems to be a general rule that amputations at joint levels require no tension at the suture line whereas amputations through the shafts of bone will permit light tension at the suture line. In this regard I would draw your attention to a procedure I saw recently in the Orthopaedic Hospital in Copenhagen where Dr. Knud Jansen (10) finalized the procedure with a single posterior vertical scar. This is done in a manner similar to that of Velpeau (6) by employing a roughly circular incision around the upper limit of the shank with the knee flexed (Fig. 1). The characteristics of the operative procedure are the same as in the procedure already described, but clearly, care in the geometry of the incision is required to insure neat apposition of the skin edges. This is the procedure I propose to follow in the future as it seems to me it will insure the correct skin tension over the end of the femoral condyles and with care will avoid the problems of flap length, wound tension, and possible necrosis.

Postoperative dressing of the disarticulation is in my view not so crucial as it is in amputation in the thigh and shank of the leg, but it is still my practice to apply a rigid plaster-of-paris splint whether it is an immediate postoperative fitting situation or not.

Inevitably arguments about amputation techniques always involve the prosthesis available to satisfy the resultant stump. This is particularly true of the knee disarticulation. Modifications of the procedure abound in the literature and most are directed towards reducing the size of the bulbous

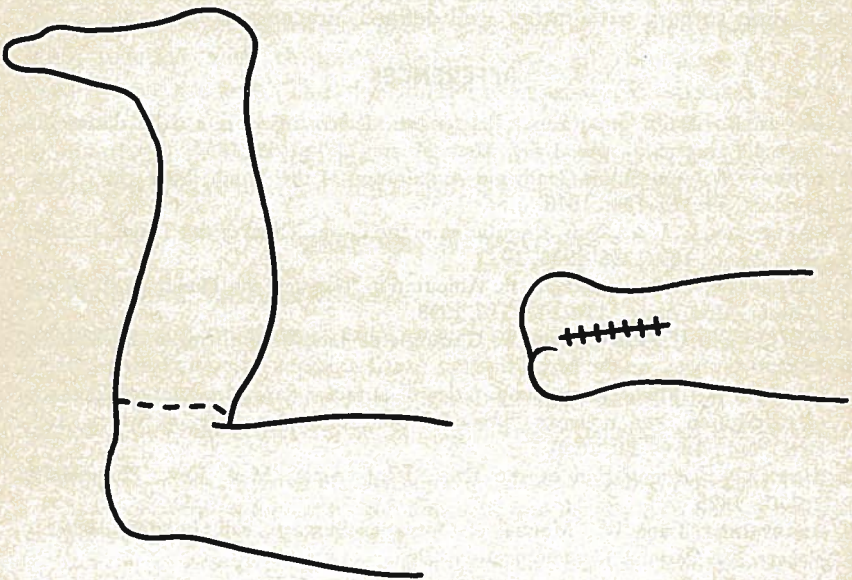


FIGURE 1.—Disarticulation of the knee. Patient prone and approach through roughly circular incision resulting in final vertical posterior scar (after Jansen).

end of the bone. I believe that provided the procedure is employed in the instances I have given, attempts of this kind are invalid. I am sure, too, that in the very near future, a more satisfactory through-knee prosthesis will be produced. The standard prosthesis with a combined thigh corset and socket made in leather with side steels and uniaxial joints provides a very satisfactory prosthesis for the young male adult by giving full end bearing and excellent suspension. In the elderly there may be problems as these patients often have associated disabilities such as weak, deformed arthritic hands. They may not have the capacity to lace up the thigh corset tightly enough to insure proper suspension and fit. We have been using a plastic socket embodying the same philosophy as the Canadian Syme's prosthesis. Twenty of these patients have been fitted with only two rejections so far. This type of prosthesis is only at the first stage of its development and no doubt someone will devise a socket which permits easy entry of the stump, full end bearing, and complete stability allied to ease of application. It seems to me to be largely an exercise in spatial geometry.

The approach used in the operation is not of great moment provided the principles involved in the treatment of the tissues are observed. Weiss of Warsaw, for example, performs the whole procedure from the posterior aspect, but I am satisfied he treats the tissues in the way described and the final stump is the same. I am persuaded that the technique employed by Jansen will probably emerge as the best available.

Whatever the approach the knee disarticulation has a definite place in amputation surgery with rather well defined indications.

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